



U.S. DEPARTMENT OF  
**ENERGY**

Office of  
Science

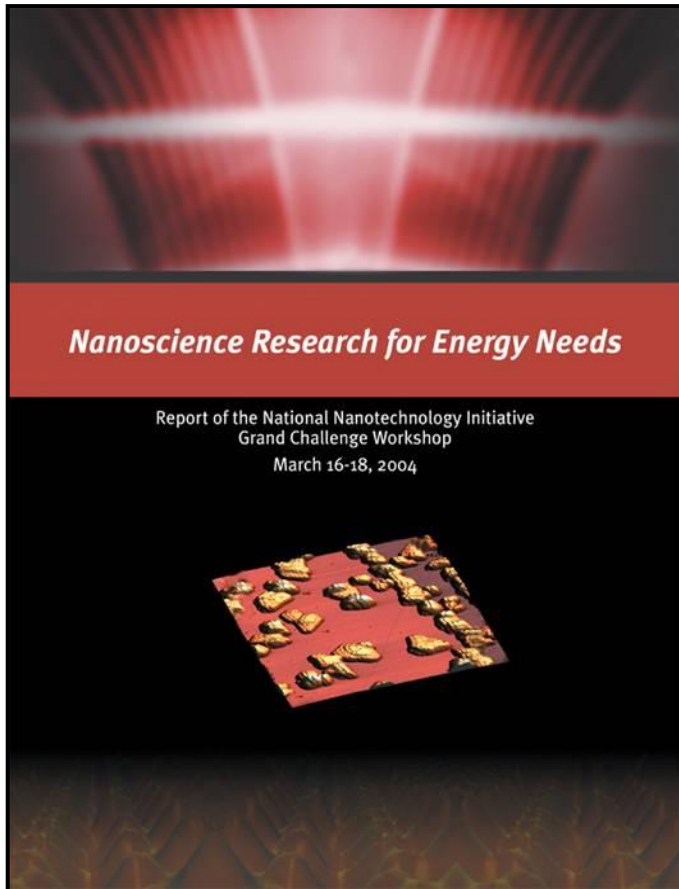
# Facing Our Energy Challenges in a New Era of (Nano) Science

Nanotechnology Innovation Summit  
December 8-10, 2010

Dr. Patricia M. Dehmer  
Deputy Director for Science Programs  
Office of Science, U.S. Department of Energy

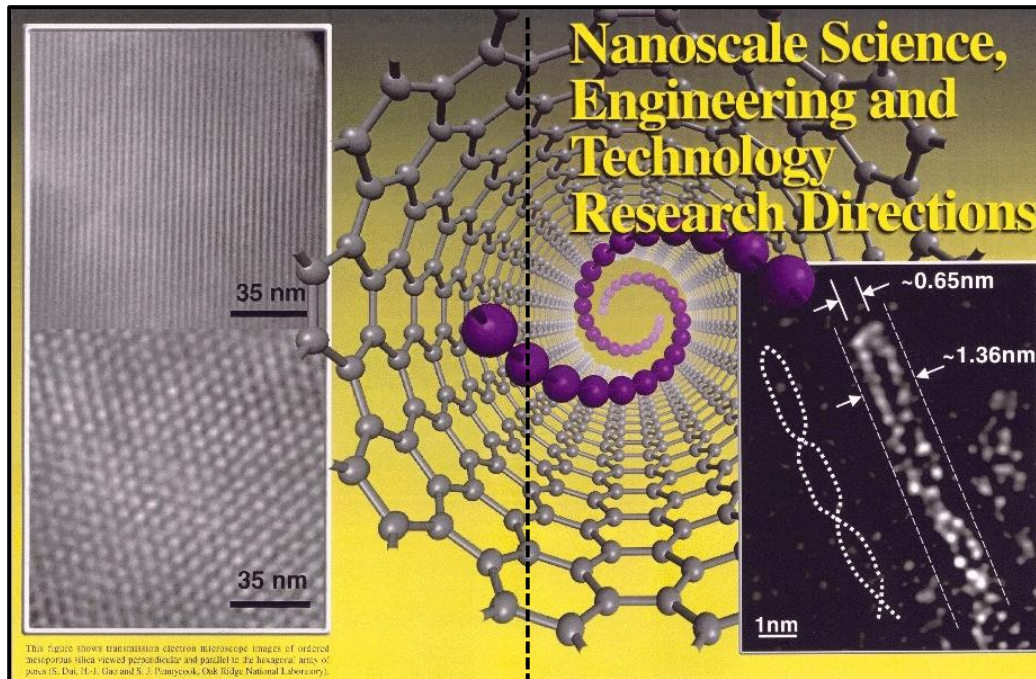
[http://www.science.doe.gov/SC-2/Deputy\\_Director-speeches-presentations.htm](http://www.science.doe.gov/SC-2/Deputy_Director-speeches-presentations.htm)

# The National Nanotechnology Initiative: Why DOE?



“At the root of the opportunities provided by nanoscience to enhance our energy security is the fact that **all of the elementary steps of energy conversion (e.g., charge transfer, molecular rearrangement, chemical reactions, etc.) take place on the nanoscale.**”

# Defining the Role of DOE in the NNI



A workshop sponsored by the Office of Basic Energy Sciences in March 1999 defined the science agenda of the Office of Science in the NNI and provided the first recommendation for “infrastructure and facilities for nanoscale science and technology;” these facilities became one of the signature contributions of DOE to the NNI.

# Nanoscale Science Research Centers

(Artists' Concepts, circa 2002)



Center for Functional  
Nanomaterials  
(Brookhaven National Lab)



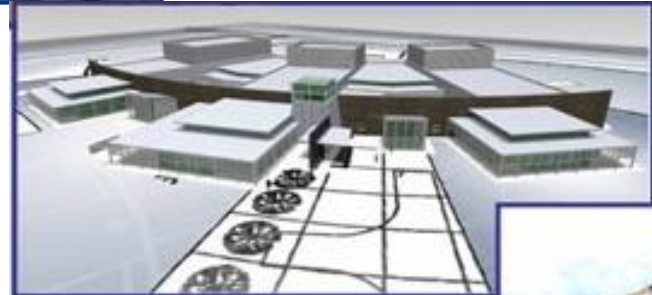
Molecular Foundry  
(Lawrence Berkeley National Lab)



Center for Nanoscale  
Materials  
(Argonne National Lab)



Center for Nanophase Materials Sciences  
(Oak Ridge National Lab)



Center for Integrated  
Nanotechnologies (Sandia &  
Los Alamos National Labs)





# Completed in 2006-2008, the NSRCs are Serving Users



**Center for Functional  
Nanomaterials  
(Brookhaven National Lab)**



**Molecular Foundry  
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**Center for Nanoscale  
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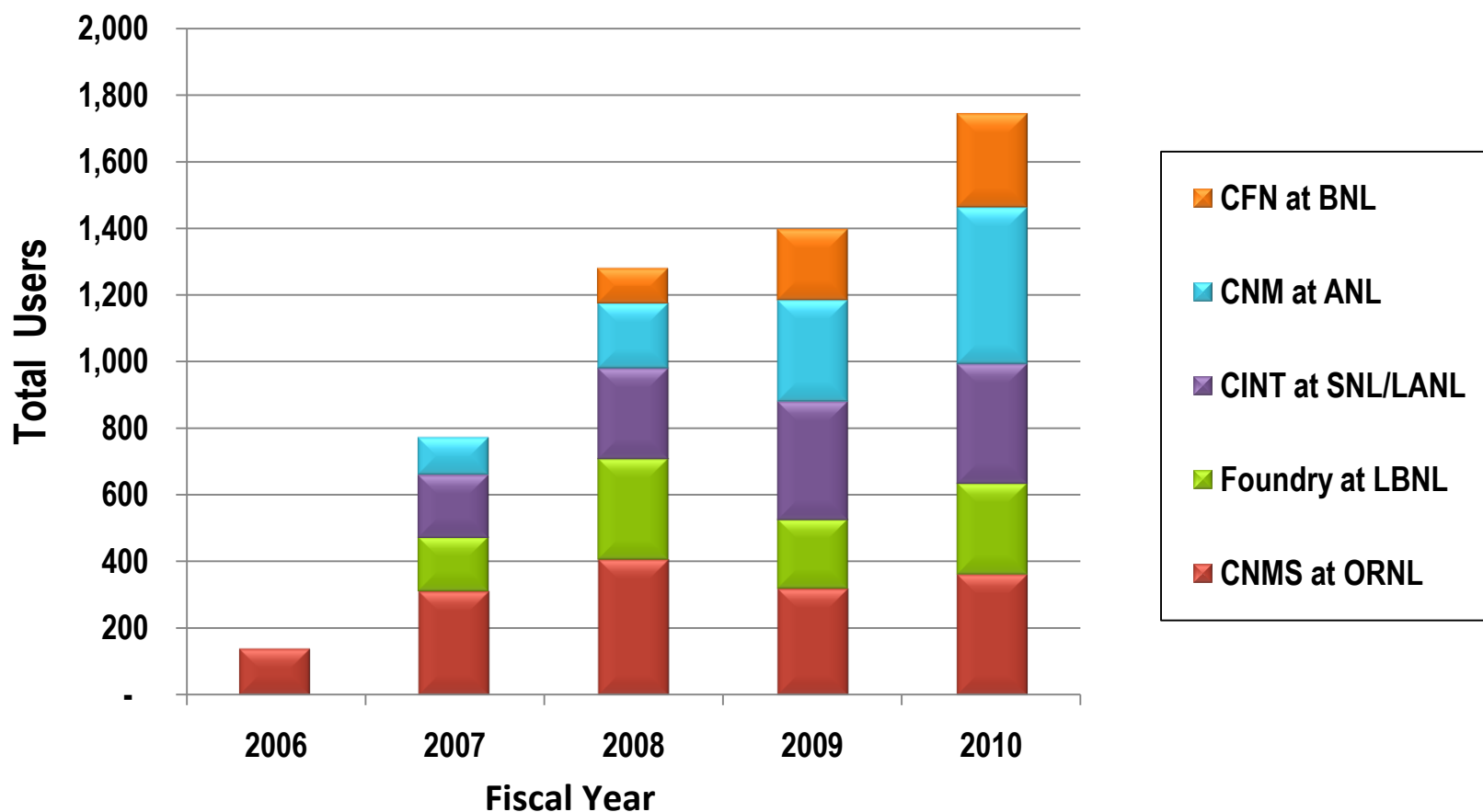
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# User Numbers at the NSRCs Continue to Increase



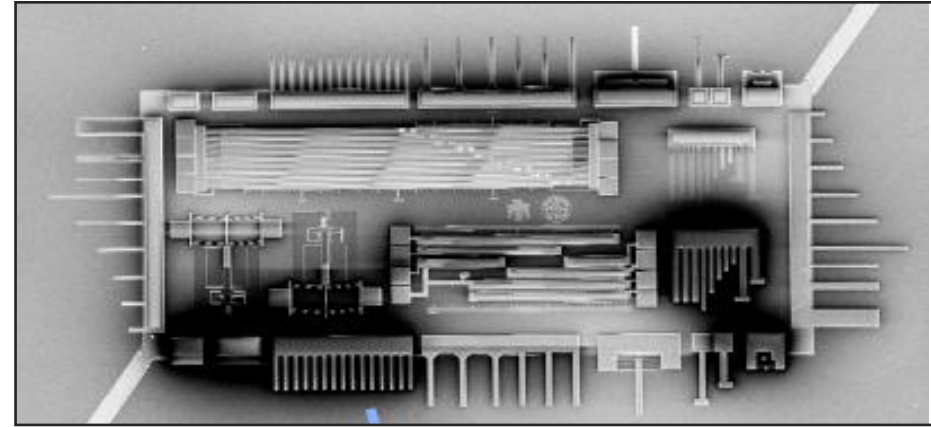
Numbers of unique users, including badged users, remote users, and, starting FY 2007, off-site users. One NSRC was in full-year operation in FY 2006, four in FY 2007, and all five in FY 2008. Over 80% of users in each year have been badged (on-site) users.

# NSRCs Create New Tools and Capabilities – Big and Small

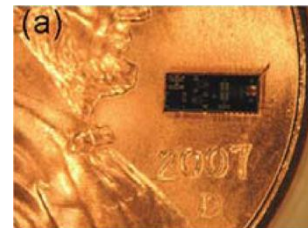


## X-Ray Beamline with Nanoscale Resolution at the Advanced Photon Source

- Unique instruments to study individual nanostructures
- Quantitative structure, strain, orientation imaging
- Sensitive trace element and chemical state analysis



**Cantilever Array Discovery Platform:** The size of an AFM chip, the CADP has multiple cantilevers projecting from all edges for nanomechanics, novel scanning probe technologies, chem and bio sensing, magnetization studies, and studies of the physics of coupled systems.



## “Discovery Platforms”: modular micro-labs for nanoscience

- Standardized and batch fabricated
- Access to a range of diagnostic and characterization tools

# NSRCs are Scientific User Facilities –

## What does that mean?

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- Available to all researchers, regardless of affiliation, nationality, or source of research support
- No cost for non-proprietary work
- Access based on peer merit review of submitted proposals
  - Proposals are evaluated by an external Proposal Review Committee or equivalent
- A limited amount of time may be allocated directly at the discretion of the facility director or management for rapid access (breaking news, very brief initial exploration, etc.)
- Majority of instruments operated by facility staff, with a large majority of time made available to general users
  - Includes on-site (badged) and remote users; at present those who send samples or view data remotely are not counted in user numbers



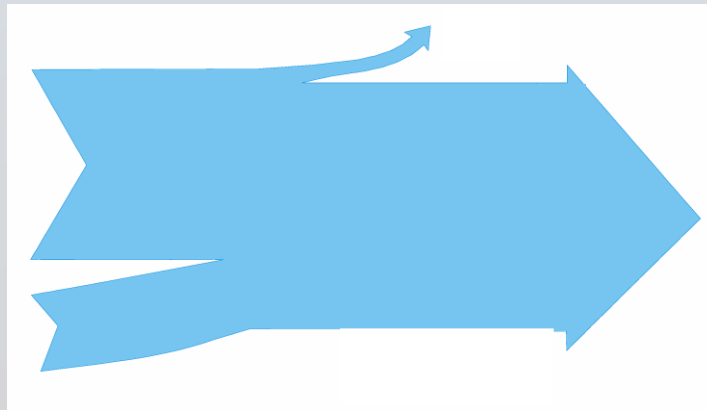
# DOE NNI Investments

in \$M (rounded)	FY 2009 (actual)	Recovery (actual)	FY 2010 (est.)	FY 2011 (request)
BES core research	108.4	0.0	113.6	115.6
BES user facilities (NSRCs)	100.5	25.0	106.3	111.4
BES EFRCs	69.6	217.7	69.6	89.6
BES Hubs	0.0	0.0	0.0	10.0
other SC (BER, ASCR)	4.8	0.0	4.8	4.8
EERE	32.1	25.0	42.9	42.9
FE	5.4	0.0	5.5	6.0
ARPA-E	0.0	0.0	0.0	31.7
<b>total</b>	<b>320.8</b>	<b>267.7</b>	<b>342.7</b>	<b>411.9</b>

For BES, SBIR/STTR on research is included in the core research line

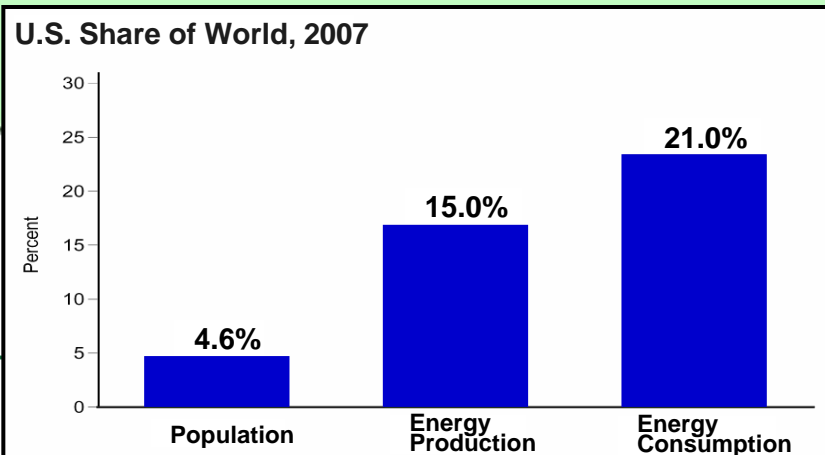
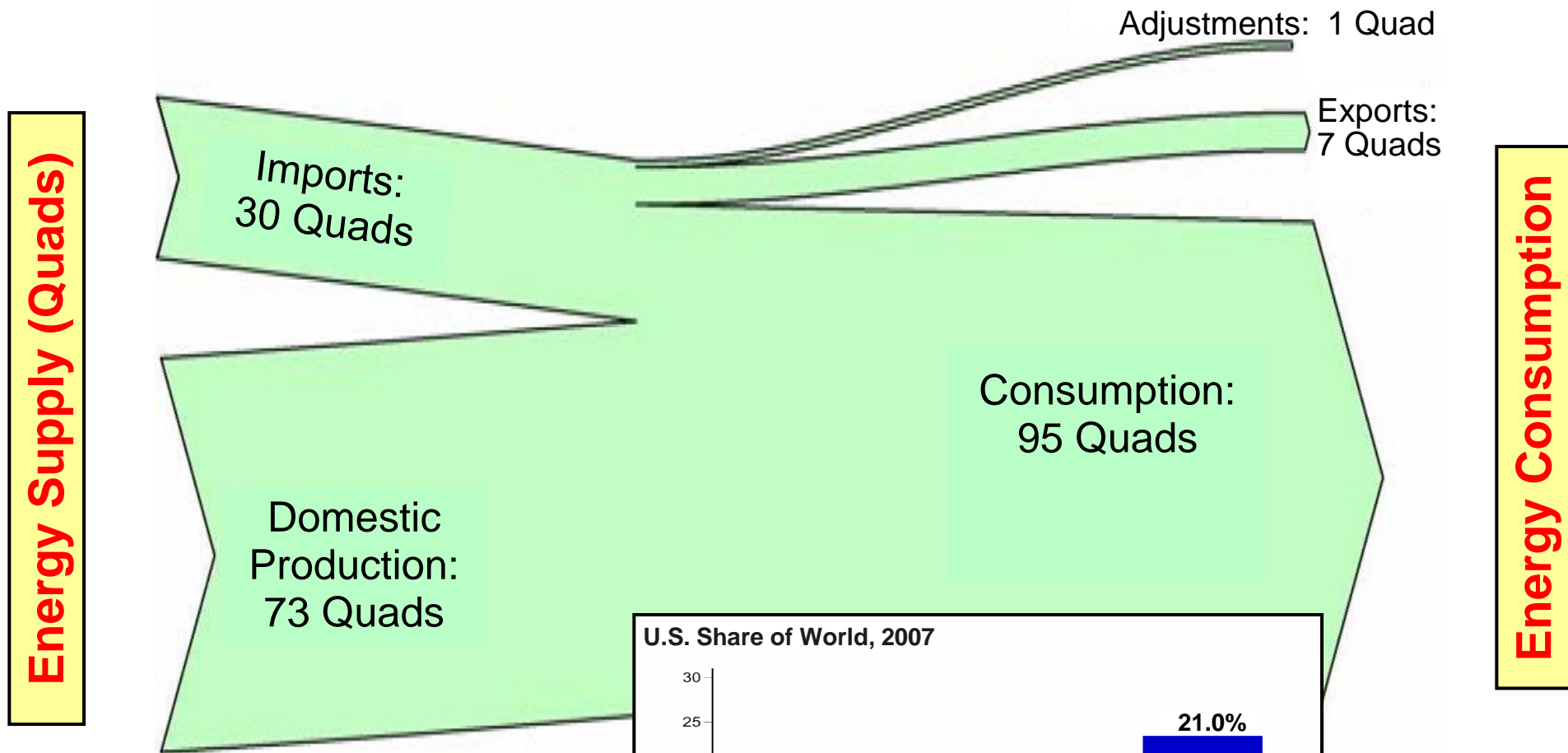
# **Nano Tutorial on Energy:**

**Energy sources and consumption sectors in the U.S.**



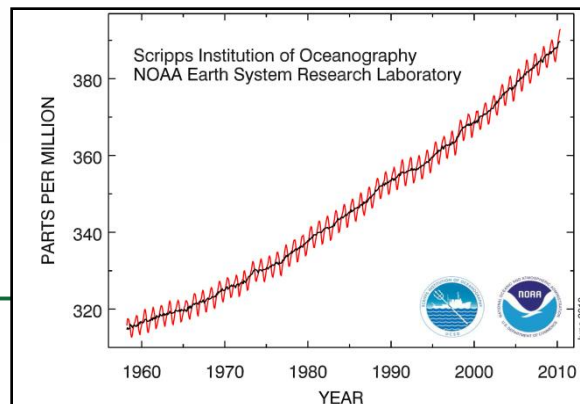
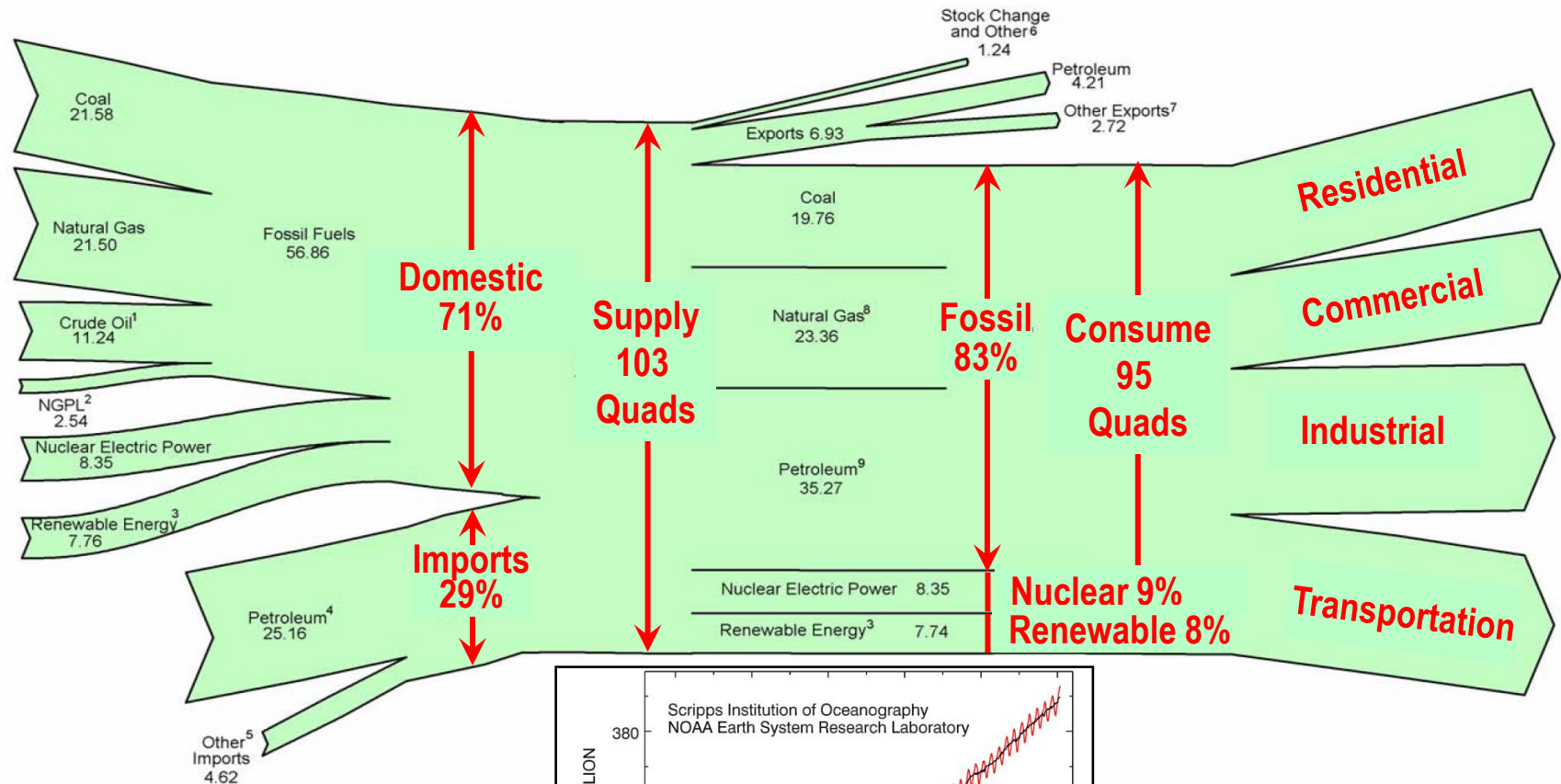
# U.S. Energy Flow, 2009

About 1/3 of U.S. primary energy is imported



# U.S. Energy Flow, 2009 (Quads)

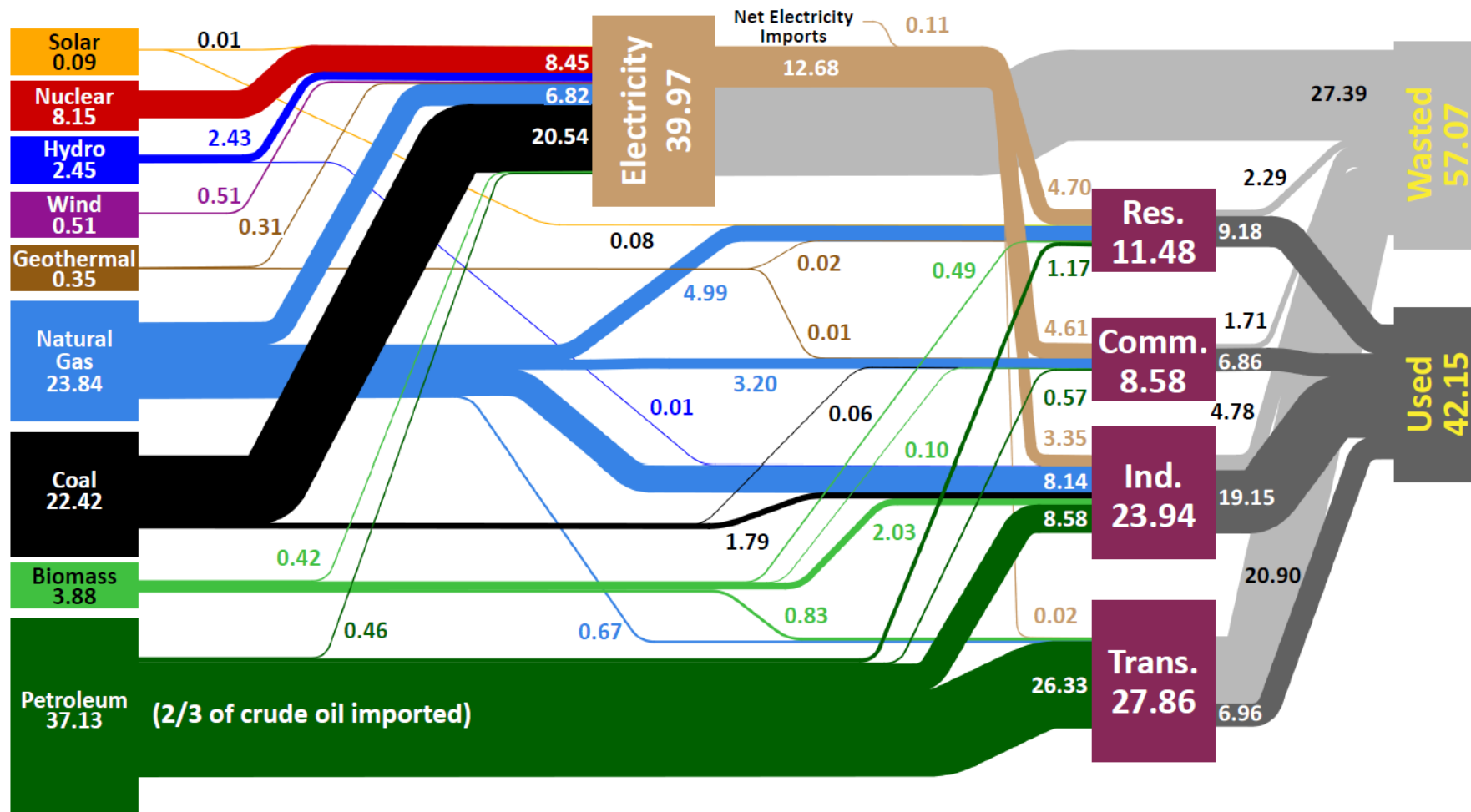
>80% of primary energy is from fossil fuels





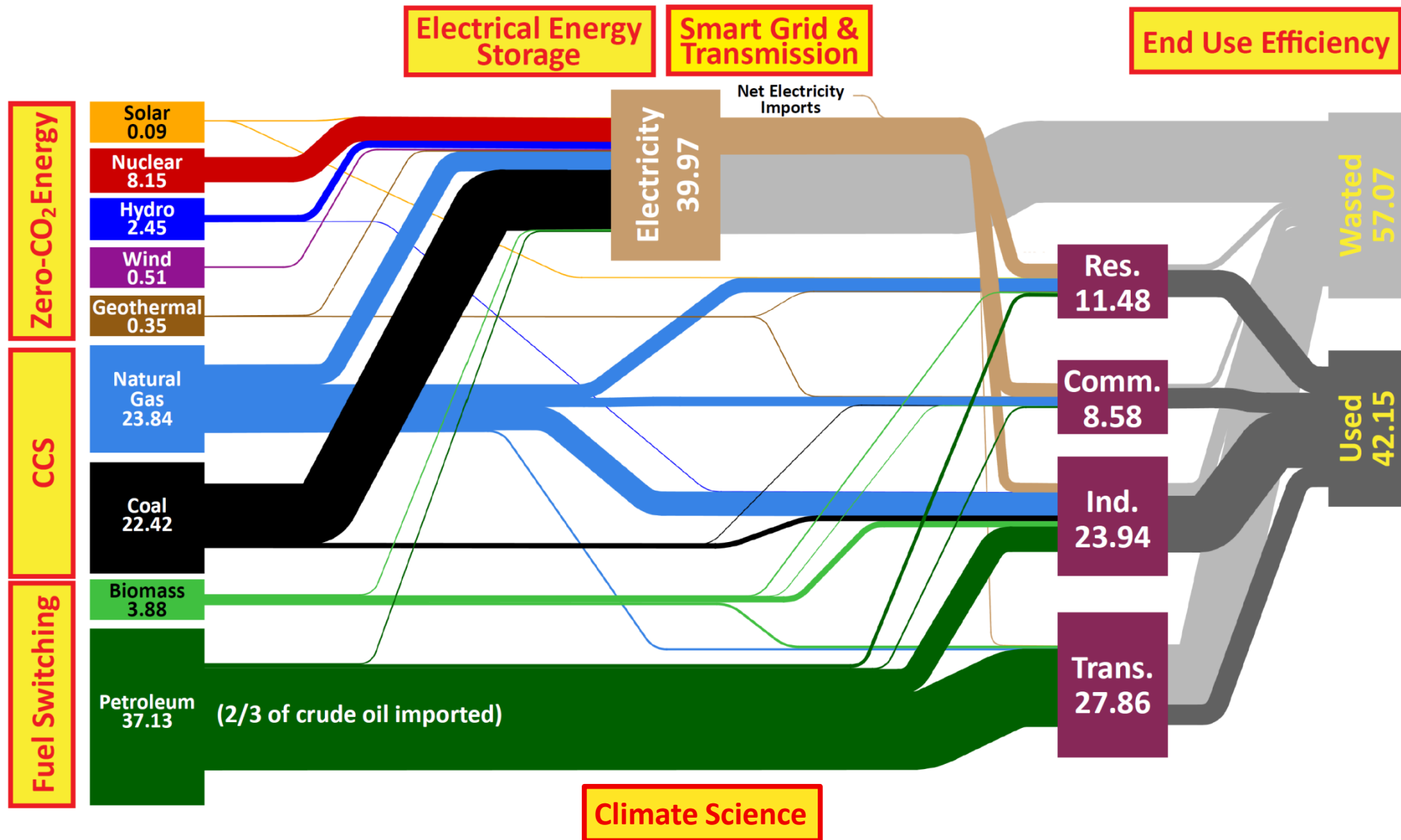
# U.S. Energy Production and Usage in 2008

*Units in Quadrillion BTUs (Quads)*



Source: Lawrence Livermore National Laboratory and the Department of Energy, Energy Information Administration, 2009 (based on data from DOE/EIA-0384(2008), June 2009).

# A National Strategy for a New Energy Economy



# A Nano Research Agenda for a New Energy Economy

**Nanostructured thin-film organic photovoltaic devices**

**Artificial Photosynthesis**

LIGHT HARVESTING

FUEL PRODUCTION

OXIDATION

CHARGE SEPARATION

REDUCTION

FUEL PRODUCTION

**Capture or separation of CO<sub>2</sub> from gas mixtures**

**Cellulose synthesis**

50 nm

Cell wall assembly

Plant material properties

**Structure of lignocellulose at the nanoscale and the rules by which plants create this material**

**High-Tc and high current superconductors for grid and other electrical applications**

**Nanoscale science of materials, interfaces, charge transport & cycling, mechanical stability**

Nanostructured electrodes

Uniform arrays of heterogeneous multifunctional nanostructures

material 1 material 2

Electrical energy storage system

11.48

Comm.  
8.58

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**Conversion of electricity to light using new designs, such as luminescent nanowires, quantum dots, and hybrid architectures;**

Photonic Lattice LED (Sandia)

UV LED (Sandia)

Haze LED Luminaire (Industrial Micro Systems)

Water Cube in Beijing (2008 Olympic Games)



# Take the “Beat-the-Leaf” Challenge



**END**